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Final Observations on the Nipah Palm as a Source of Alcohol.

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Four reports have been published in previous issues of this journal under this heading* and recent reports have been published in the Philippine Journal of Science by Cole and Wells and Perkins and in the Bulletin of the Imperial Institute by Wood.†

The present article gives the results of tapping observations and estimations of alcohol content of the juice obtained from nipah palms cultivated on two large plantations.

Tapping has been carried out by this department, since 1922 by the Forest Department of British North Borneo and latterly by the proprietors of Tinggi River and Sungei Burong Estates on their cultivated palms.

By the courtesy of the latter it has been possible for this department to carry out direct observations on the yield and alcohol content of juice on these estates.

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*This Journal Vol. XI (1923) pp. 47—59. Vol. XII (1924) pp. 154—162. Vol. XIII (1925) pp. 64—71. Vol. XIV (1926) pp. 64—71.

†Philippine Journal of Science Vol. 20 (1922) pp. 45—54. Vol. 21 (1922) pp. 1—46. Bulletin of the Imperial Institute Vol. 23 (1925).

For a summary of tapping until September 1925 when experimental tapping on existing indigenous areas ceased, reference should be made to previous issues of this journal.*

Observations on tapping areas.

A. *Sungei Burong Estate.*—The palms on this area are now nearly five years old, are remarkably well-grown and have shewn continual fruiting throughout the observation period. The leaf is of a dark green colour, the fruit stalks are of excellent length and thickness and the fruits themselves very large, shewing a high degree of fertilisation.

The top soil contains a considerable amount of humus and had a salt content of 0.95 per cent in June last, while the sub soil had a content of 1.70 per cent. The reduction in the salt content of the sub soil since 1924 is slight, but in the case of the top soil the reduction amounts to about forty per cent. It is probable that the salt content is now of the order of 0.2—0.6 per cent. (see Tinggi River below).

B. *Tinggi River Estate.*—The palms were considerably retarded by the 1926 floods (salt water). The inundation caused an increase in the salt content of the top soil from 1.09 per cent. in 1924 to 1.87 per cent. soon after the floods subsided. By fresh water flooding since then the salt content in some fields has been reduced to as low as 0.22 per cent. for the top soil and 0.58 per cent. for the sub soil. The effect of this fresh water flooding on growth has been excellent and the palms generally are now making great headway.

The fruit stalks are thinner than on Sungei Burong but on the other hand are appearing in greater numbers. As many as twenty-six fruit in various stages of growth have been counted on one palm.

The water supply on both estates is controlled by means of gates.

Tapping Results from Sungei Burong.

The most complete results have been obtained from Sungei Burong estate where up to 120 palms at a time have been under conservative tapping.

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*Malayan Agricultural Journal Vol. XI March 1923, Vol. XII June and July 1924, Vol. XIII March 1925, and Vol. XIV, December 1926.

The mean yield per spathe per day has been summarised from the daily tapping figures for each month of tapping. The figures are given in Table I.

Interpretation of Table I.

(1) The figures in column 7 in general (spathes x days) are the product of the number of spathes in a task and the number of days in the month.* The exceptions to this are when a spathe goes out of tapping during a month, in which case the figures are a summation of the number of days for which each spathe, in a given task, flows or is tapped during the month.

The mean yield per day (column 8) is obtained by taking the total yield of a task during a month and dividing by the figure in column 7.

(2) The figures in brackets in column 8 apply to the spathes which have only been tapped once a day. This figure is obtained by multiplying the figure immediately in front of it, by 1.41. It gives a calculated figure for twice daily tapping for palms actually tapped once.* These calculated figures have been used for obtaining the true mean (see below).

(3) The figures in the last column are obtained by taking the total yield of a given task for the month, and dividing by the number of days in the calendar month concerned and the number of spathes in tapping irrespective of whether they are yielding throughout the month.

(4) The true mean of column 8 (mean daily yield per spathe per day tapped) has been obtained by dividing the total amount of juice obtained during the whole period of observation (893630 oz. or 5580 gallons)† by the total of spathe days in the previous column. This gives maximum true mean.

The true mean of the last column is obtained in a similar way but the divisor is the same as in § (3) above. This gives a minimum figure.

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*Night tapping only x 1.41 = day + night tapping. Day tapping only x 3.45 = day + night tapping. These figures have been found to be remarkably constant throughout the period of observation.

†The figures include the extra calculated juice. See interpretation of Table I § (2) above.

Table I.

Summary of Tapping on Sungei Burong Estate.

1 Month.	2 Task No.	3 Days gon-chang-ing.	4 Times tapped daily.	5 No. spathes tapped.	6 No. days tapped monthly.	7 Spathes x days.	8 Mean yield per spathe per day tapped. (a) (oz.)	9 (b) Galls.	10 Daily mean on monthly total per spathe.	11 Remarks.
Sept.	1	20	2	25	30	750	10.56	0.066	10.56	
1926	2	30	2	35	30	1035	10.54	0.066	10.54	
	3	30	1	22	30	660	7.77 (10.95)	0.048	7.77	
	4	15	2	25	15	475	14.54	0.091	14.54	
	5	20	2	33	various	203	8.54	0.054	8.67	
	6	15	2	25	13	325	13.54	0.082	13.54	
Oct.	1	20	2	22	31	682	11.91	0.075	11.91	
1926	2	30	2	35	31	1085	14.82	0.093	14.82	
	3	30	1	19	31	589	14.35 (20.22)	0.090	14.35	
	4	15	2	25	31	775	20.63	0.129	20.63	
	5	20	2	32	31	992	14.42	0.090	14.42	
	6	15	2	35	27	945	17.56	0.110	17.56	
November, December & January 1927 no figures.										
Feb.	1	15	2	52	28	1456	25.90	0.162	25.90	
1927	2	15	1	54	6	324	7.34 (10.34)	0.046	1.60	New spathes cut.
	3	15	2	various	various	1277	21.25	0.133	15.00	
	4	15	1	do.	do.	1044	11.95 (16.84)	0.075	8.20	

TABLE I—(*continued.*)

Summary of Tapping on Sungei Burong Estate.

1 Month.	2 Task No.	3 Days gon-chang-ing.	4 Times tapped daily.	5 No. spathes tapped.	6 No. days tapped monthly.	7 Spathes x days.	8 Mean yield per spathe per day tapped. (a) (oz.)	9 (b) Galls.	10 Daily mean on monthly total per spathe.	11 Remarks.
Mar.	1	15	2	60	31	1860	30.50	0.190	30.50	
1927	2	15	1	55	various	1600	23.33 (32.83)	0.146	21.80	
	3	15	2	65	do.	1916	23.50	0.146	22.40	
	4	15	1	60	do.	1210	9.64 (13.58)	0.060	6.27	
April	1	20	2	60	27	1620	22.40	0.140	22.40	
1927	2	20	1	various	various	1512	17.71 (24.96)	0.111	11.25	
	3	20	2	do.	do.	404	12.05	0.075	2.31	Tapping stopped by floods.
	4	20	1	do.	do.	1444	5.00 (7.04)	0.031	4.00	Tapping stopped by floods.
May	1	20	2	do.	do	1450	16.40	0.102	12.80	Tapping interrupted by floods.
1927	2	20	1	do.	do	597	9.00 (12.68)	0.056	6.80	Tapping interrupted by floods.
	3	20	2	No tapping	flow stopped	by floods				
	4	20	1	various	various	1566	11.75 (16.55)	0.073	9.00	
June	1	20	2	58	30	1740	18.43	0.115	17.85	
1927	2	20	1	various	various	2020	10.00 (14.00)	0.062	8.45	

TABLE I—(*continued.*)

Summary of Tapping on Sungei Burong Estate.

1 Month.	2 Task No.	3 Days gon-chang-ing.	4 Times tapped daily.	5 No. spathes tapped.	6 No. days tapped monthly.	7 Spathes x days.	8 Mean yield per spathe per day tapped. (a) (oz.)	9 (b) Galls.	10 Daily mean on monthly total per spathe	11 Remarks.
July	1	20	1	80	various	1763	7.95 (11.20)	0.050	3.60	
1927	2	20	1	10	31	310	17.14 (24.14)	0.107	17.14	
	3	20	2	60	31	1860	19.00	0.119	19.00	(1 spathe a.m. 1 spathe p.m.)
	4	20	2	65	31	2015	13.93	0.087	13.93	
Aug.	1	20	2	35	31	1085	11.96	0.075	11.96	
1927	2	20	1	7	31	217	11.05 (16.00)	0.069	11.05	
	3	20	2	22	31	681	9.13	0.057	9.13	Mean of two spathes.
	4	15	2	21	11	231	7.40	0.042	7.40	Mean of two spathes.
	5	20	2	70	various	770	6.76	0.042	6.76	
	6	20	2	65	do.	1785	9.99	0.062	8.39	
Sept.	1	20	2	80	30	2400	9.67	0.060	9.67	Mean of two spathes.
1927	2	15	2	30	23	690	8.52	0.053	8.52	Mean of two spathes.
	3	20	2	80	30	2400	11.90	0.075	1.90	Half available spathes in tapping.
	4	20	2	77	30	2310	10.84	0.069	10.84	Half available spathes in tapping.
Oct.	1	15	2	30	various	840	9.50	0.059	18.54	Mean of two spathes.
1927	2	20	2	66	do.	1552	12.77	0.079	0.08	Mean of two spathes.
	3	20	2	80	do.	2082	10.13	0.063	17.73	Half available spathes in tapping.
	4	20	2	75	do.	1725	11.00	0.069	8.24	All available spathes in tapping.
						True mean	16·4	0.1025	14.46	

Thus two true means are obtained, a maximum and a minimum. In discussing their significant difference it must be remembered that an experimental tapping area with only one or two coolies at work, cannot possibly be treated as efficiently as in organised tapping where it would be the task of special coolies to keep spathes under observation as tapping progressed, and to take care that another spathe had been gonchanged and was in bearing just before the previous spathe had finished. The real true mean therefore probably lies nearer the maximum than the minimum.

The significance of these figures as regards yields per acre is further considered in connection with the potential alcohol content of the juice.

Tinggi River Tapping.

The object of Tinggi River tapping has been, not so much to determine yield as to discover the number of spathes available for tapping per palm and the effect of heavy tapping on the general health and recovering powers of the palms.

As the experiments were only initiated in September last sufficient time has not elapsed for definite conclusions to be reached.

The preliminary figures are given in table II.

The interpretation of the figures in this table is similar to that of table I. Circumstances were such that it was impossible to carry out twice daily tapping on Tinggi River until November, and the yield for twice daily tapping therefore had to be calculated by using the appropriate factor. The figures must be regarded as preliminary as the tapping area is only gradually being brought into bearing as the spathes mature.

There are no signs of the tapping having any deleterious effect on the palms of either Sungei Burong or Tinggi River estates.

General Observations on Methods of Tapping.

In connection with the above tapping records it is necessary to make a few further observations on the methods of tapping.

TABLE II.

1	2	3	4	5	6	7	8	9
Month	Task	Days gon-chang-ing	Tapped	Spathe days	Mean yield per spathe per day tapped (a) once (b) twice daily		Mean spathes per palm	Remarks
Sept. 1927	1	20	Day only	1529	3.47	11.97	2.75	Col. 7= Col. 6x 3.45
	2	20	,,	888	3.06	10.83	5.00	,,
	3	20	,,	1067	4.07	14.04	1.38	,,
	4	20	,,	640	3.92	13.52	1.58	,,
Oct.	1	20	,,	1535	5.94	20.50	2.25	,,
1927	2	20	,,	1445	4.90	18.90	2.25	,,
	3	20	,,	701	5.02	17.27	2.00	,,
	4	20	,,	713	3.71	12.80	2.00	,,
Nov. 1927	1	20	Twice daily	565		17.40	3.10	
	2	20	Day only	1491	6.95	20.80	2.90	Col. 7= Col. 6x 3.45

It is essential that the stalk should undergo a preliminary treatment known as "gonchanging" (lit. strike with the foot). The process is started when the fruit-head is fairly well-grown but before any darkening of the seed takes place. It consists of gently oscillating the fruit once a day. As the fruit-head grows the violence of the operation is increased until it becomes a good hard kick or violent shaking by hand.

After considerable observation of this operation it would appear that its utility lies in the fact that it prevents the cells from hardening and atrophying as the stalk matures. Examination of "gonchanging" and "ungonchanged" stalks shew the latter to be hard and dry while the former are comparatively soft and supple.

Experience has shewn three weeks to be a suitable length of time for this operation, any increase in the period tending to increase labour costs uneconomically.

The saccharine juice obtained as a wound response, (mentioned above) as it drips from the stalk contains neither alcohol, acid nor reducing sugars, only cane sugar, salts and bodies of the proteid type.

It has been suggested that sugar could be obtained by cutting down the leaves and fruit stalks, crushing and collecting the juice exuded. Experiments carried out by this department, recently, have shown this to be a fallacy. The average sugar content per leaf stalk is only 0.7 per cent and of the fruit stalk 0.43 per cent. Thus removing one leaf stalk per palm would only yield 0.75 gallons of alcohol per acre while the large amount of foreign bodies would complicate fermentation and the palm would be quickly exhausted if not killed.

Preservation and Collection.

The question of preservation and collection of the juice has already received considerable attention and it is not out of place in this connection to summarise the position.

There appear to be four practicable alternatives for preservation: —

(a) Preservation with lime

(b) Preservation with sulphuric acid

(c) Sterile collection

(d) Autofermentation.

It is now generally accepted that the tremendous bulk of liquid involved necessitates a pipe line system for the collection of the juice on a plantation scale,

This system has been considerably discussed by people interested in plantation nipah and all are agreed that with this bulk of liquid to be handled daily, pipe lines are essential.

Two forms seem worthy of consideration, an open bamboo flume or an iron pipe. The objections to the former are that it would require to be renewed fairly frequently and would form a host for all sorts of undersirable organisms and a breeding ground for mosquitos.

(a) *Preservation with lime.*—As considerable bulk of lime is required this would tend to choke the pipe and for this reason must be rejected.

(b) *Preservation with sulphuric acid.*—An iron pipe would be attacked by this acid continuously unless it is arranged to neutralise the acid with lime before passing the juice into the pipe.

(c) *Sterile collection.*—The juice would have to be collected in glazed vessels capable of being washed daily, sterilising immediately on arrival at the factory and subsequently inoculating with a pure culture yeast. The objections to this procedure lie in extra capital cost for collecting vessels, sterilisers, yeast cultivation plant and pure culture vats; also extra running costs.

(d) *Autofermentation.*—If collected from porous pots and supplied to the pipe twelve or twenty four hours after tapping the juice will contain sugar, alcohol and small amounts of acetic acid. The latter will tend to corrode the pipe but after a time the ferric acetate formed may have a tendency to form an insoluble coating and so preserve the pipe. In any case the use of a suitable anti-corrosive paint would probably reduce the corrosion to an insignificant figure.

With such a prolific yielder as nipah appears to be, if the acid does not amount to more than one per cent. of the juice (see below) it would seem, after consideration of the readily available methods of preservation, better to allow fermentation to occur naturally. The acid may be removed subsequently, as acetate of soda or lime, which can be used for the preparation of acetic acid as such.

The Potential Alcoholic Content of the Juice.

For the purpose of estimating the alcoholic content of the juice in the field a Dujardin ebullioscope was used. This

was found to work very well, distillation methods agreeing almost exactly with these boiling point determinations.

Residual sugar was estimated with Fehlings solution and acidity titrated in the usual way.

The alcohol equivalent was calculated as the sum of the alcohol found and the alcohol obtainable from the residual sugar on a 92 per cent. efficiency basis.

The results are given in table III below.

1.25 = ratio of Alcohol by Volume to Alcohol by Wt.

TABLE III.

1 Date of Sample.	2 Date Examined.	3 Alcohol by vol. per cent	4 Sugar per cent	5 Alcohol equivalent by volume per cent.	6 REMARKS.
28.4.27	29.4.27	10.5	Unexamined	Not less than 10.5	Sample taken at random
28.4.27	29.4.27	8.2	do	„ 8.2	do
29.4.27	29.4.27	2.7	11.5	10.5	Average of 20 samples
12.5.27	12.5.27	1.7	14.9	11.0	Average of 6 samples
„	„	1.0	14.8	10.2	High yielding palm
„	„	1.1	15.1	10.5	Average of 20 samples
„	„	...	18.2	11.4	Low yielding palm
„	„	1.2	14.1	9.9	High yielding palm
25.5.27	26.5.27	6.7	5.8	10.8	Average of 50 samples
„	„	9.4	1.2	10.1	High yielding palm
„	„	8.6	3.2	10.6	do
„	„	7.7	5.5	10.1	Low yielding palm
„	„	9.9	0.5	10.2	do
26.5.27	„	4.4	9.8	10.5	Average of 50 samples
„	„	5.0	8.5	10.3	High yielding palm
14.6.72	15.6.27	5.6	5.4	9.0	do
„	„	5.2	6.4	9.2	do
„	„	5.5	7.3	10.1	Average of 50 samples
„	„	4.0	8.0	9.0	do
„	„	6.7	7.7	11.4	Low yielding palm
„	„	6.2	7.0	10.6	do
26.6.27	28.6.27	10.3	1.1	10.9	High yielding palm
„	„	10.3	nil	10.3	21 Samples taken at random
„	„	10.3	nil	10.3	
„	„	10.4	nil	10.4	
„	„	10.3	0.45	10.6	
„	„	10.4	0.70	10.8	
„	„	10.8	nil	10.8	
„	„	10.8	nil	10.8	

TABLE III—(*Contd.*)

1 Date of Sample	2 Date Examined	3 Alcohol by vol. per cent	4 Sugar per cent	5 Alcohol equivalent by volume per cent	6 REMARKS.
26.6.27	28.6.27	9.7	nil	9.7	
,,	,,	9.3	0.82	9.8	
,,	,,	9.7	nil	9.7	
,,	,,	8.6	0.80	9.1	
,,	,,	8.0	0.80	8.5	
,,	,,	9.1	1.10	9.8	
,,	,,	9.9	nil	9.9	
,,	,,	10.1	nil	10.1	21 Samples taken at random
,,	,,	11.0	nil	11.0	
,,	,,	10 1	nil	10.1	
,,	,,	10.6	nil	10.6	
,,	,,	10.1	nil	10.1	
,,	,,	11.8	nil	11.8	
,,	,,	10.6	nil	10.6	
,,	,,	8.5	nil	8.5	
,,	,,	8.6	nil	8.6	
27.6.27	28.6.27	8.9	4.0	11.4	High yielding palm
,,	,,	8.2	2.4	9.7	do
,,	,,	8.7	2.1	10.0	Low yielding palm
18.7.27	19.7.27	nil	16.3	10.2	Acidity 0.21
					20.7.27 0.48
19.7.27	19.7.27	nil	16.32	10.2	Acidity 0.45
					20.7.27 0.51
19.7.27	21.7.27	9.9	nil	9.9	Acidity 1.02
,,	,,	9.6	nil	9.6	do 0.96
,,	,,	9.6	nil	9.6	do 0.96
,,	,,	10.1	nil	10.1	do 1.00
,,	,,	9.9	nil	9.9	do 1.00
,,	,,	10.1	nil	10.1	do 1.02
26.9.27	27.9.27	7.8	2.87	9 6	do 0.40
,,	,,	4.6	6.69	8.9	do 0.53
,,	,,	6.9	4.80	9.9	do 0.60
,,	,,	8.9	1.76	10.0	do 0.60
26.9.27	29.9.27	7.3	3.20	9.3	do 1.60
26.9.27	28.9.27	9.9	0.4	10.1	do 0.70
,,	,,	7.4	3.0	9.3	do 1.60
,,	,,	10.0	nil	10.0	do 0.76
,,	,,	9.2	nil	9.2	do 1.50
,,	,,	10.1	nil	10.1	do 1.60
,,	,,	10.2	nil	10.2	do 0.76
	,,	9.8	nil	9.8	do 0.45
,,	,,	11.1	nil	11.1	do 0.56
,,	,,	9.5	0.4	9.7	do 0.36

TABLE III—(*Contd.*)

1 Date of Sample	2 Date Examined	3 Alcohol by vol. per cent	4 Sugar per cent	5 Alcohol equivalent per cent	6 REMARKS.	
24.10.27	27.10.27	6.3	6.8	10.5	do	2.00
,,	,,	6.3	6.8	10.5	do	2.00
,,	,,	7.6	5.0	10.7	do	1.20
,,	,,	8.8	4.0	11.3	do	1.30
,,	,,	8.7	5.0	11.8	do	1.20
,,	,,	5.2	6.2	9.1	do	0.58
				Mean 10.09		

YIELD OF ALCOHOL PER ACRE.

The maximum true mean per spathe per day in table I of 16.4 oz. or .1025 gallons, on a basis of 2 spathes in tapping per palm 200 palms per acre, and 340 tapping days per annum gives 1025 x 340 x 200 x 2 gallons of juice per acre per annum.

The mean figure for alcohol content equivalent from table III is 10.0 per cent by volume. Hence it would seem reasonable to assume that the mean yield of alcohol per acre per annum would be 1394 gallons.

In a similar way taking the minimum true mean the figure would be 1270 gallons.

Thanks are due to Commander A. P. Mackilligan and the Proprietors of Sungei Burong for placing the experimental tapping at my disposal, and to the resident manager, Mr. E. C. White for the help he has given me in connection with these observations.

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Alcohol Fuel and the Nipah Palm
A popular outline.

J. H. Dennett.

Fuel Supplies.

Considerable attention has been given in recent years in all parts of the world to the question of the exhaustion of petrol supplies.

Whether these supplies will be exhausted in ten, fifty or a hundred years, the fact remains that the supply of petrol is definitely limited. Most of the evidence tends to shew that the exhaustion point is nearer that of a decade than of a century, with the reservation that new sources of supply may be discovered in hitherto such little explored or exploited regions of the world as central Asia.

As the known supplies of petroleum are definitely limited it is necessary that other fuels should be considered. Of these the two most promising are (ethyl) alcohol, and, in view of the recent work in Germany, coal.

In regard to the latter, here again the supply of raw material is strictly limited and as far as Germany is concerned it would seem to be a case of supplying internal needs for some years to come, rather than contributing to the worlds supply generally.

Power Alcohol.

Alcohol to be used for power purposes is essentially the same as the alcohol contained in potable liquids except that it has been concentrated by distillation until it is of about 95 per cent. purity.

The raw materials for the supply of alcohol are inexhaustable as it is prepared from vegetable material capable of being continually replaced.

In Malaya we are dependant entirely on outside sources for our petrol and quite apart from any question of war it would seem a reasonable proposal to make this country self-

supporting in liquid fuel such as alcohol provided the latter is efficient* and can be put on the market at such a price that it can compete successfully with other fuels.

Assuming that alcohol can be put on the market at such a price the main sources of supply of raw material would be starch and sugar bearing materials.

Under the former heading, as far as Malaya is concerned would be listed rice,† maize, cassava, sweet potato, and sago. Under the latter coconut palm, nipah palm, nibong palm and sugar cane.

Rice and maize can be ruled out as far as Malaya is concerned, as, for many years to come, all the locally grown rice and maize will be required as foodstuffs. To sago of which there is but a negligible quantity the same remarks apply. Cassava and sweet potato might be cultivated for the preparation of alcohol, but compared with the sugar-bearing crops its preparation from these materials is complicated.‡ The maximum yield obtainable would be about 600 gallons per acre per annum and probably average not more than half this amount.

The coconut and the nipah palm are the two most promising sources of alcohol in this country but the former must be discounted by the fact that it is a valuable food producer and would require a labour force of skilled toddy tappers or trained monkeys to exploit it.

Nipah however is tapped at a height of only four feet from the ground and moreover shews promises of giving yields greater than any obtainable from other sources.

Nipah Palm.

Four reports have been published in previous issues of this journal under this heading§ and recent reports have been published in the Philippine Journal of Science by Cole

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*The results of a few engine tests are appended at the end of this article.

†A large amount of arrack is produced in Java from broken rice grain.

‡Cassava is an important source of alcohol in parts of the world where molasses are not available.

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and Wells and Perkins and in the Bulletin of the Imperial Institute by Wood.*

The earlier publications in the Philippines by H. D. Gibbs and Pratt may be said to be responsible for calling general attention to Nipah.†

The subject has been given a large amount of attention recently both by the local press and by individuals and it is therefore felt that it would be of value if the subject were dealt with from a somewhat wider point of view than has been done up to the present.

Indigenous & Plantation Nipah.

It is essential that nipah should occur in large areas for its successful exploitation.

In the Philippines and British North Borneo, two of the three countries which have considered Nipah as a commercial proposition, it has been viewed as the exploitation of a forest product rather than an agricultural proposition as such large areas occur there naturally.

As a plantation product, in addition, it must be capable of continuous exploitation, so that the skilled labour force which would have to be acquired, would not be periodically discharged and re-engaged.

Further in the Philippines and British North Borneo nipah only fruits, and can therefore only be tapped, from four to six months of the year.

Locally it has been definitely proved that Nipah can be tapped throughout the year without injury. As there are no compact stands of Nipah in Malaya of the order of those in British North Borneo and Philippines, the palm would have to be planted here in bulk before it could be exploited.

This fact immediately renders it worth consideration as an agricultural proposition.

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*Philippine Journal of Science Vol. 20 (1922) pp. 45—54, Vol. 21 (1922) pp. 17—46. Bulletin of the Imperial Institute Vol. 23 (1925).

†Philippine Journal of Science 1911, '924

Without such planted areas of Nipah being left to themselves to fend against other vegetation, until they arrived at an "indigenous" state (i.e. no upkeep costs) the indigenous palm could not be considered, in Malaya.

Plantation Nipah presents the following advantages over indigenous Nipah

1. Permanent labour force.
2. Ease of exploitation and control.
3. Probable increased yields.
4. Compactness.

The first two of these are obvious. The third is of general occurance with cultivated as against wild products (c.f. rubber, oil-palm, camphor etc.) Compactness will mean a saving of transport and general labour costs.

Under the heading of plantation nipah it may be mentioned that two large estates, Tinggi River and Sungei Burong have already been planted up with Nipah in the Kuala Selangor district. A large area of these is already in bearing and has afforded much useful information on growth and yields (see previous article in this issue).

The Palm.

The Nipah Palm has been described many times by various writers, so that it requires but little notice here.

It is a stemless plant with pennate leaves which vary considerably in length with environment, but which probably average between 20 and 30 feet. The stalk branches from the root proper some two feet below ground. The plant propagates itself in two ways, from seed, and by continuous outgrowth from the parent palm, the original dividing first into two three or four, after which there is a dying off of the original centre fronds. These divisions in time sub-divide again so that pruning must be resorted to to prevent an area becoming "filled".

The fruit stalk from which the juice is obtained grows between the fronds and reaches a height of three to four feet at maturity. The male and female flowers grow on the same stalk and pollination occurs through the agency of bees and ants.

The fruit which takes about three months to reach maturity is about twelve to fifteen inches in diameter when full grown. The earliest fruiting recorded is two years and three months, some of the palms on Tinggi River Estate having fruited at this age. The average age is about three years, but nipah does not reach maturity until some two or three years later. The stalks and fruit of young palms are generally undersized.

The tapping of the palm is discussed on page 439.

Soil & Habitat.

Nipah Palm is said to inhabit the mouths of tidal rivers, but more correctly, the mouths of tidal rivers above what may be described as the mangrove line, i.e. where the water is not as salt as the sea, but is salter than the non tidal water.

It is evident that Nipah is a semi-aquatic plant and as such requires a heavy clay soil capable of retaining a high percentage of water. The alluvial mud flats of the coastal belt are admirably suited to its requirements. It will grow on such a soil with little humus, but observations have shewn that growth is considerably improved when organic material is present in quantity.

At the nursery stage nipah thrives best in brackish water, but at an age of about two years it appears to do best when the salt content of the water and soil is very considerably reduced, in fact observations tend to shew that a high salt content of the soil when the palms are in bearing reduces yields.

Planting, Etc.

Previous Reference has been made to planting in this journal* and the general lines mentioned there have to a large extent been adopted.

The usual practice now is to plant 200 palms to the acre which gives a planting distance of 12 ft. x 18 ft. staggered, instead of 12 ft. x 16 ft. as then suggested.

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*Vol. XI No. 3 March, 1923, p. 59.

The seedling after removal from the nursery (i.e. after reaching about a span high) are planted in drains, three feet wide by 1 foot deep the seedling being actually placed in a recess or pocket cut in the side of the drain, so that when grown the palm will not interfere with the flow of water along these planting drains from or to the main estate "parits".

As the type of land on which Nipah thrives is usually infested with crabs, which feed on the shoots of the young seedlings it is necessary to protect them in their early stages by putting a small bamboo "pagar" around the seed on planting out. The growth of the palm for the first six months is always slow but once established growth is rapid.

It is estimated that the maximum total cost of bringing Nipah into bearing is about $60 per acre. (at three years).

Drains.

It is essential that palms should have a continual supply of water, which entails the fitting of water gates so that the supply may always be maintained at any required level. If rainfall is not sufficiently evenly distributed through the year for such maintenance, then pumping must be resorted to from the nearest river. It is assumed that salt water is always more or less available through the situation of the land.

Tapping.

If the almost mature nipah fruit head is cut off from the end of the fruit stalk, a highly saccharine juice exudes therefrom as a wound response. If the wound is prevented from healing up by the daily or half-daily removal of a thin slice of the stalk, this flow will continue for months.*

It is essential that the stalk should undergo a preliminary treatment known as "gonchanging" (lit. strike with the foot). The process is started when the fruit-head is fairly well-grown but before any darkening of the seed takes

*It has been suggested that sugar could be obtained by cutting down the leaves and fruit stalks, crushing and collecting the juice exuded. Experiments carried out by this Department, recently, have shown this to be a fallacy. The average sugar content per leaf stalk is only 0.7 per cent. and of the fruit stalk 0.43 per cent. Thus removing one leaf stalk per palm would only yield 0.75 gallons of alcohol per acre while the large amount of foreign bodies would complicate fermentation and the palm would be quickly exhausted if not killed.

place. It consists of gently oscillating the fruit once a day. As the fruit-head grows the violence of the operation is increased until it becomes a good hard kick or a violent shaking by hand.*

Experience has shewn three weeks to be a suitable length of time for this operation, any increase in the period tending to increase labour costs uneconomically.

The saccharine juice obtained as a wound response, (mentioned above) as it drips from the stalk contains neither alcohol, acid, nor reducing sugars, only cane sugar, salts and bodies of the proteid type.

Fermentation.

It has been usually assumed that the basic principles or ideas underlying the production of alcohol from saccheriferous or sugar-yielding plants are generally understood.

But from conversation with people interested and from letters and enquiries which reach this Department from time to time in connection with Nipah Palm as a source of alcohol, the conclusion has been reached that a general explanation of these principles would not be out of place in an article dealing with Nipah Palm.

Cane sugar is a complicated organic (as opposed to mineral) compound composed of Carbon, Oxygen, and Hydrogen which when treated with acids or the complex body "invertase" splits up into two simpler sugars "glucose" and "fructose" which are similar in chemical composition. Approximately they may be said to be treacle and honey respectively.

Yeasts (which contain invertase) are some of the most elementary forms of plant life, consisting of single cells which reproduce themselves by budding from the parent cell. They are capable of feeding on glucose and fructose producing alcohol and carbonic acid gas as metabolic products of this feeding. This process is usually called fermentation.

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*After considerable observation of this operation it would appear that its utility lies in the fact that it prevents the cells from hardening and atrophying as the stalk matures. Examination of "gonchanged" and "ungonchanged" stalks shew the latter to be hard and dry while the former are comparatively soft and supple.

These yeast cells (about one-five thousandth of an inch in diameter) are always floating about in the air, particularly in tropical countries, so that, if any sugar solution (such as nipah juice) is left exposed, a certain number of cells fall into the containing vessel and fermentation is set up.

Unfortunately besides yeasts there are other organisms present in the air capable of converting alcohol into acetic and other acids.

Thus one starts with a solution of cane sugar obtained from nipah juice into which yeasts fall; the invertase (of the yeast) starts to convert the cane sugar into glucose and fructose. These sugars are then eaten by the yeast with production of alcohol; this alcohol in its turn is slowly attacked by other organisms and converted to acetic acid. A stage arrives when all the sugar is used up and the ratio of alcohol to acid is at a maximum; this period is reached generally some twenty four to thirty six hours after collection.

Preservation and Conveyance of Juice.

Autofermentation in the field immediately gives rise to the question of preservation and its advisability.

It is considered that sulphuric acid is the best preservative for a juice to be used for alcohol preparation; results obtained by this method were given in a former issue of this journal.*

Cream of lime has been used in the Philippines and Borneo as a preservative "per se" but there are objections to its use from the distillers point of view.

Assuming that the juice is preserved and conveyed to the factory and there treated with a pure culture yeast under sterile conditions will there be a sufficient saving of alcohol to warranf the extra costs involved?

In the collection of nipah juice as a forest product boats are used, a slow and inefficient method. A properly laid out plantation on the other hand obviously lends itself to a pipe line system.

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*Malayan Agricultural Journal Vol. XIV, December 1926.

This system has been considerably discussed by people interested in plantation nipah and all are agreed that with the tremendous bulk of liquid to be handled daily, pipe lines are essential.

Two forms seem worthy of consideration, an open bamboo flume or an iron pipe. The objections to the former are that it would require to be renewed fairly frequently and would form a host for all sorts of undesirable organisms.

An iron pipe has the advantage of being enclosed; the further question now arises, what will be the effect of the juice on the pipe (i) unpreserved (ii) preserved with lime (iii) preserved with sulphuric acid.

(i) *Unpreserved.*—If collected in porous pots and supplied to the pipe after twelve or twenty four hours the juice will contain sugar, alcohol and small amounts of acetic acid. The latter will at first tend to corrode the pipe but after a time the ferric acetate may have a tendency to form an insoluble coating and so preserve the pipe.

(ii) *Preserved with lime.*—As considerable bulk of lime is required this would tend to choke the pipe and for this reason must be rejected.

(iii) *Preserved with sulphuric acid.*—An iron pipe line will be attacked by this acid continuously unless it is arranged to neutralise the acid with lime before passing the juice into the pipe.

It thus seems best not to preserve the juice at all, but to let it ferment naturally, unless the loss of alcohol should become unexpectedly high. In the latter case a fourth alternative would have to be considered viz. to collect the juice in glazed vessels capable of being washed daily, sterilizing the juice immediately on arrival at the factory and subsequently inoculating with a pure culture yeast. The objections to this procedure lie in extra capital costs for collecting vessels, sterilisers, yeast cultivation plant and pure culture vats; also extra running costs.

With such a prolific yielder as nipah appears to be, if the acid does not amount to more than one per cent. of the juice it would seem, after consideration of the readily available methods of preservation, better to allow fermentation to occur naturally. The acid may be removed

subsequently, as acetate of soda or lime, which can be used for the preparation of acetic acid as such.*

For results of tapping and alcoholic content of the juice reference should be made to the previous article in this issue and to previous numbers of this journal.†

Distillation and the Distillery.

The fully fermented juice contains only some ten per cent of alcohol by volume and it is therefore necessary to concentrate it by a process of distillation.

Essentially the juice now consists of a mixture of alcohol and water with acetic acid as an impurity.

The distillation of such a mixture presents more difficulty say, than the distillation of such an oil as citronella, which may be obtained by simply blowing steam through the grass and condensing the vapours evolved; the water subsequently being run off from the overlying layer of oil.

Alcohol is unfortunately miscible with water in all proportions, so that such a method cannot be resorted to.

Pure alcohol boils at 79°C and pure water at 100°C so that if a mixture of the two is heated there is a tendancy for the alcohol to boil away more readily than the water and this property is made use of for the purpose of concentration.

If the mixed vapours given off on heating are submitted to the cooling action of a large exposed surface, the water vapour will be condensed more readily (owing to its higher boiling temperature) than alcohol, and so will drop back into the boiling vessel while the alcohol still remains in the form of vapour.

Thus a partial separation takes place; it is by an elaboration of this partial separation that alcohol of ninety-five per cent purity is obtained.

Essentially, a plant for the production of ninety-five per cent. alcohol, consists of a closed column into which dry

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*See Appendix.

†M.A.J. Vol. XI March 1923, Vol. XII June—July 1924, Vol. XIII March 1925, and Vol. XIV December 1926.

steam can be led at the bottom; this column is fitted with perforated plates at intervals.

The alcoholic wash is fed to the upper plates, tending to trickle down slowly. The dry steam passing upwards volatilises most of the alcohol and some of the water, which then passes up the column through the perforations. As it passes upwards the water vapour condenses with some of the alcohol vapour and drops down again to be met by more steam and re-volatilised, until the wash reaching the bottom of the column is free from alcohol: the spent wash then passes out at the bottom of the column. On the other hand the vapour reaching the top of the column is almost free from water. This passes through a condenser and is collected in a receiver.*

The main features of the distillery will be (i) a boiler house for the production of high-pressure steam (ii) a series of fermenting vats into which the juice is run or pumped as it arrives at the factory, (iii) alcohol distillation and rectification plant (iv) ether preparation and distillation plant.†

The fermenting vats must be capable of holding not less than forty-eight hours supply of juice so that one day's supply of juice shall not interfere with that of the previous day.

These vats must all be connected by a pumping system to a constant level reservoir from which the still is fed.

The juice passes from this reservoir through a preheater. In modern stills the cold wash is passed through the alcohol vapour condenser, thus using up the heat contained in the hot vapour. From the preheater the wash then passes to the top of the distilling column as described above.

As it is assumed in this article that alcohol is to be used for power purposes it will be necessary to convert part of the alcohol after distillation into ether. The process is described in a previous issue of this journal.‡

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*The vapour may be passed in addition through a deacidifier (a vessel containing caustic soda or lime) to free it from acid. (See appendix).

†See Malayan Agricultural Journal Vol. XIV March, 1925.

‡Malayan Agricultural Journal Vol. XIV March, 1925 for notes on production costs and costs of plant see same issue.

The ether obtained is now distilled in much the same way as the alcohol, except that owing to its low boiling point special precautions have to be taken unregard to the condenser, the water for which should be specially cooled if necessary.

APPENDIX.

1. Results of Engine Tests.

A few road tests were carried out by the writer a short time ago with a standard Morris Oxford car fitted with a Smith five jet carburetter to which no alteration was made. The air intake was altered, as required, by the control on the steering column.

The following table shews the mixtures used and the miles per gallon obtained.

Fuel.	Petrol per cent.	Alcohol per cent.	Ether per cent.	M.P.G.
A	100	—	—	29.6
B	70	30	—	27.2
C	30	70	—	24
D	20	50	30	24.8
E	—	70	30	22.0
F	—	50	50	23.4

The following comments are offered on the tests made: —

A.—This was taken as the standard. The air intake was opened to the fullest extent and the acceleration was taken as normal. Knocking if spark not given retardation on hills at speeds below 20 per hour.

B.—This is an exceptionally smooth running fuel Air intake opened to fullest extent. No tendency at all to knock.

C.—The running was smooth. Air could be given to the fullest extent at high speeds. It was essential to cut the air down almost entirely to pick up quickly from speeds below 15 miles per hour. No tendency to knock.

D.—Very smooth running. Air open to fullest extent except for hills. Very little tendency to knock.

E.—Running smooth. The air had to be cut down slightly even for fast running, for slow running air cut down considerably. No tendency to knock.

F.—Running fair. Air had to be regulated as for E. There was a strong tendency to "knock" at low speeds and on hills; the spark had to be retarded to a maximum for all corners and hills.

The running of all the mixtures except "F" was considered satisfactory. C,D & E shewed much the same mileage, E being slightly less than C & D as would be expected on theoretical grounds. The same remarks apply to cutting down of the air.

The engine ran much cooler with mixtures, the difference shewn by a thermometer fitted to the radiator being about 5°.

A further advantage of alcohol fuels not so obvious in general running tests is smaller tendancy to piston and cylinder carbonization and little tendancy for fuel getting past piston rings to dilute the lubricating oils.

The only disadvantage from the general users point of view is the smaller mileage obtained . This was greatest in the case of E and amounted in the above tests to 1 gallon of petrol being equal to 1.35 gallons of "E".

Such a figure is in practical agreement with theory.

If however an alcohol mixture can be put on the market at a figure such that the decreased mileage is compensated for by the decreased cost, it offers many advantages over petrol.

2. A note on the Preparation of Acetic Acid.

Concentrated or glacial acetic acid of about 95 per cent is manufactured from crude acetate of soda or lime by distilling it with the appropriate quantity of sulphuric acid.

The crude acetate is melted, then allowed to cool and broken up into small lumps.

These small lumps are placed in a lead lined chamber together with the sulphuric acid. The chamber is steamed heated and the acetic acid evolved is passed through a condenser and collected in two portions, the first one of which contains water as well as acid. The second portion contains the concentrated acid.

Received for publication 22nd December, 1927.

Ustulina Zonata, (Lev.) Sacc.—A Warning Note.

F. W. South.

Attention is invited to the prevalence of the Dry Rot fungus, *Ustulina zonata*, on the stems and main branches of rubber trees on several of the older rubber estates, especially in the coastal districts of Selangor. The attack usually occurs on a large branch, or on the main fork, at a spot where a wounded surface is present owing either to the careless pruning of a lateral branch, or to damage caused by wind, or by an accident such as the felling of another tree when thinning out is in progress. The fungus is carried to the wounded surface by wind or by boring insects, especially beetles, which can convey spores of the fungus, or small pieces of infected material, on their bodies.

The prevalence of this disease on old rubber tree stems and branches affords a practical illustration of the soundness of the advice, consistently given by the Department of Agriculture, as to the importance of burning felled trees and all large pruned branches on estates with the greatest possible despatch, and as to the need to exercise care in pruning. If the large portions of rubber trees are left lying on the ground, or if dead stumps are not promptly removed after thinning out, the fungus will almost invariably attack them and in due course produce very large numbers of its spores on their surfaces, so providing a liberal source of infection.

Even though such sources of infection are carefully destroyed, it must be remembered that the fungus is fairly generally prevalent, so that it is always advisable to protect wounded surfaces and to make sure that any necessary pruning is properly done.

When removing a large branch, the first cut should always be made on its under side close to the trunk, or larger branch, from which it is being removed and should penetrate to about one third of its thickness. The branch should then be cut through from the upper side at a point a few inches further out than the cut on the under side. As a

heavy branch nearly always falls before it is cut completely through, this method prevents it from tearing a strip of bark and wood out of the trunk or larger branch to which it was attached. No hat pegs should be left, but all branches, or stubs of large branches cut off in the manner described above, should be removed at their junction with another branch, or with the main trunk, and the wounded surface should be smoothed with a sharp instrument and be thoroughly tarred at once. One or two further dressings of tar should be applied at intervals of about three weeks. Wounds caused by wind or accidents should be smoothed off with a sharp instrument and care should be taken to leave no hollows in which water can collect. Such wounds should also be dressed two or three times with tar.

If attention is given to these preventive measures the losses caused by *Ustulina zonata* and other fungi capable of attacking rubber trees through wounded surfaces can be much reduced.

Supplementary Note on Methods of Destroying Dead Coconut Palms.

F. R. Mason.

This note is supplementary to a short article, on the same subject, published in the *Malayan Agricultural Journal* Vol. XV—No. 8, 1927. Since the publication of the original note, mentioned above, the writer has witnessed another method of burning dead coconut timber which may be of use to those confronted with the problem of destroying felled palms from areas on which it is impossible to burn in situ, i.e., on areas where the subsequent crop is too advanced to allow of burning with safety, or where coconuts are cut out from mature rubber, as is often done.

In this case it is necessary that the coconut timber be removed to an open space where burning can take place with safety. Having chosen a spot, accessible to all parts of the felled area, a trench is dug, say 3 feet wide, 2 feet deep, and about 12 feet in length, this gives a permanent 'flue' over which are piled, crosswise, first a number of lengths of trunk and on top of these the stumps and other lengths of trunk, up to a height of 8—10 feet. (Vide Fig. 1.)

The trench is filled with dead leaves and other rubbish which can be easily ignited. The burning is just as effective and the same body of heat is obtained. In this case it is quite unnecessary to split the trunks or the stumps. After putting down the first layer of trunks it will be found an easy matter to build others on top by using two lengths of trunk as runners and rolling the remainder up on to the pile with the aid of two coolies with levers.

This method is of course more expensive than burning in situ, as it entails extra labour in carrying out the timber. It is surprising how quickly an area can be cleared of timber by a gang of coolies carrying out the trunks and stumps with the aid of slings.

If space permits, it is advantageous to dig two trenches sufficiently far apart to enable the building of a second pile

to be carried on while the other is burning, a gang of coolies is thus kept employed practically the whole time.

For this method to be effective it is essential to see that all timber is packed as close together as possible and all placed the same way, never criss-cross fashion.

Note.—Owing to a misunderstanding Figure 2 behind page 296 of Volume XV of the *Malayan Agricultural Journal* does not correctly illustrate the description given in the text of "A note on the methods of Destroying Dead Coconut Palms." Fig. 2 accompanying this article should be substituted.

Fig. 1

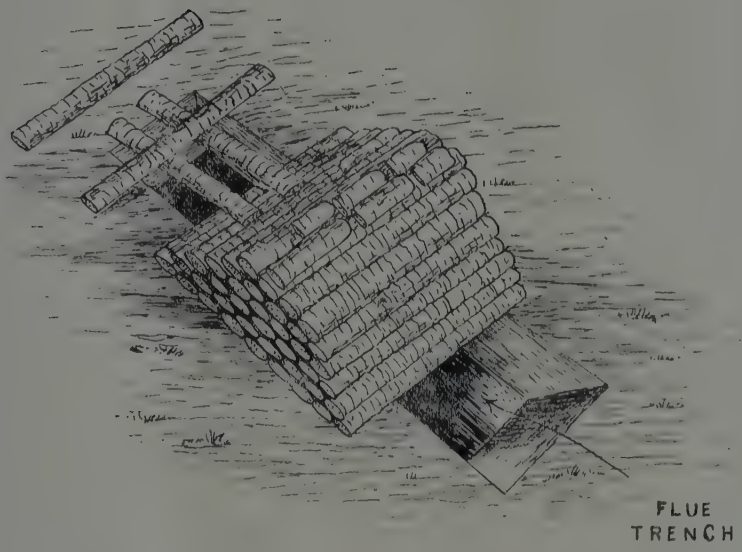
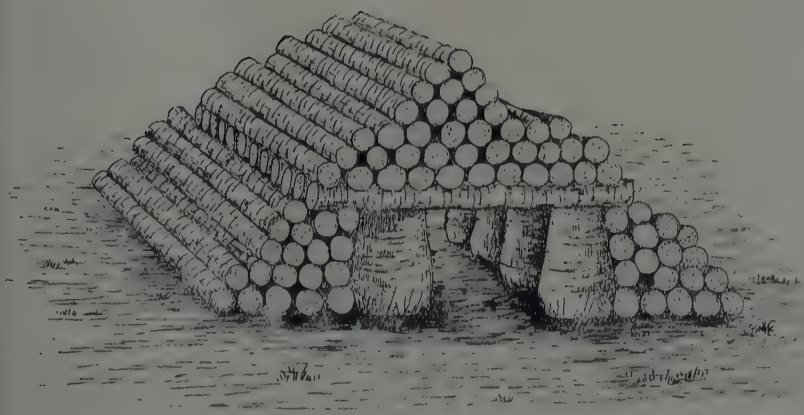


Fig. 2



London Market Price List 1927.

Oil Seeds.

Castor (Bombay)	-	£19.10.0	to £17.12.6	per ton
Copra (Ceylon)	-	27. 7.6	to 29. 7.6	,,
Copra (Straits)	-	25.15.0	to 28. 5.0	,,
Cotton Seed	-	8.15.0	to 10. 8.9	,,
Desiccated Coconut (fine)	-	1.19.6	to 1.17.6	per cwt.
Desiccated Coconut (medium)	-	1.19.6	to 1.17.3	,,
Ground nut (Hull)	-	19. 7.6	to 22.12.6	per ton.
Linseed (Bombay)	-	17. 2.6	to 17.	,,
Linseed (Plate)	-	16.17.6	to 15.15.0	,,
Palm Kernal (West African)	-	19. 7.6	to 20.15.0	,,

Oils.

Castor (First pressing)	-	£49.10.0	to £47.10.0	,,
Coconut (Cochin)	-	52	to 55	
Coconut (Ceylon)	-	46.10.0	to 45	
Cotton Seed (Egyptain Crude)	-	31.15.0	to 35.10.0	,,
Ground nut (Crude)	-	44	to 45	,,
Linseed	-	30.15.0	to 30.5.0	,,
Palm (Lagos)	-	1.15.3	to 1.15.9	,,
Palm Kernal	-	38	to 38.15.0	,,

Oil Cakes.

Coconut	-	£8.12.6	to £10.2.6	,,
Coconut (Egyptian Seed)	-	6. 5.0	to 7.1.3	,,
Coconut (Bombay Seed)	-	5. 7.0		,,
Ground nut (London decorticated)	-	11.10.0		,,
Linseed 9%	-	11.12.6	to 11.7.6	,,
Palm Kernal	-	7.15.0	to 9.10.0	,,

Essential Oils.

Cajeput	-	2/6	to 2/4½	per lb.
Camphor (Chinese Crude)	-	2/6	to 2/3	,,
Camphor (Japanese refined)	-	2/8½	to 2/3	,,
Camphor Oil (White distilled)	-	£2.17.6	to £3.2.6	per cwt.
Cinnamon (Ceylon leaf)	-	6/8	to 4/9	per lb.
Citronella (Ceylon)	-	1/5		,,
Citronella (Java)	-	1/11½	to 1/8	,,
Clove (90 to 92%)	-	5/6	to 4/6	,,
Lemon Grass (Cochin)	-	3/7	to 3/4	,,
Lime (West Indian distilled)	-	£1	to £1.6.0	,,
Patchouli (Penang and Singapore)	-	2.2.6	to 1.12.0	,,
Vetiver (Bourbon)	-	1.17.6	to 1	,,
Vetiver (Java)	-	1.13.0	to 1.10.0	,,

Spices.

Capsicums (East Indian)	£2	to	£3.10.0	per cwt.
Capsicums (Nyassaland)	3	to	3.15.0	,,
Chillies (Zanzibar)	3	to	7.10.0	,,
Chillies (Nyassaland)	3	to	8	,,
Chillies (Japan)	4.15.0	to	6.10.0	,,
Cinnamon (Ceylon)	2/3			per lb.
Cloves (Zanzibar)	/9	to	/7¼	,,
Cloves (Penang)	2/-	to	1/8	,,
Ginger (Japan)	£2.17.6	to	£2.10.0	per cwt.
Ginger (Jamaica)	4	to	1.17.6	,,
Mace (Bombay)	3/10	to	3/9	,,
Nutmegs (Singapore and Penang)				
110's	1/7	to	1/5	,,
80's	1/11	to	1/8	,,
64—57's	2/5			,,
Pepper (Singapore black)	/10½	to	1/4	,,
Pepper (Singapore white)	1/5½	to	2/1	,,

Drugs.

Chaulmoogra (genuine)	2/11			per lb.
Ipecacuanha (Rio)	£1	to	£0.15.6	,,

Natural Dyes and Extracts

Annatto	/3			,,
Gambier (block)	£1.15.0			per cwt.
Gambier (cube)	3			,,

Gums and Resins.

Damar (Singapore)	£1.10.0			,,
Damar (Batavia)	6.5.0			,,
Dragon's blood (reed) Nom.	15	to	£20 throughout the year	,,
Gutta Percha (Genuine)	2/9	to	6/-	,, per lb.
Gutta Percha (Sarawak)	/3	to	4/-	,, ,,
Gutta Percha (Siak, reboiled)	1/5	to	/11	,, ,,

Fibres.

Cotton (American G. O. to Mid.)	4.84d.	to	10.06d	,,
Cotton (Egyptian Sakallarides G. F. to Fine)	13.00d	to	17.90d	,,
Hemp (Manila 'J' grade)	£47	to	£42.10.0	per ton.
Hemp (Mauritius)	30	to	33.10.0	,,
Hemp (New Zealand)	36	to	33	,,
Hemp (Sisal)	20 - 43	to	15 - 40	,,
Kapok (Indian)	1/-	to	10½	per lb.
Kapok (Java)	1/3	to	1/1½	,,

Food Stuffs.

Arrowroot (Natal)	/8d	to	/9d throughout the year.	,,
Cocoa (Ceylon Plantation)	£3.15.0	to	£4.5.0	per cwt.

Coffee	(Malay Plantation)	-	£5.10.0 to £6.5.0 per cwt. throughout the year.
Coffee	(Liberian)	-	4.10.0 to 4.5.0 ,,
Sago	(Peral)	-	1.8.0 ,,
Sago	(Flour)	-	17/6 to 18 ,, throughout the year.
Tapioca	(Singapore)	-	2d to 2½d ,, per lb.
Tapioca	(flour)	-	18/ to 22/- ,, per cwt.
Tapioca	(Seed pearl)	-	18/ to 22 ,, ,,

Chemicals.

Acetic Acid (Glacial)		-	£66 per ton.
Acetic Acid (80% con.)		-	37 ,,
Acetone		-	62 to 59 ,,
Ammonia (880)		-	22 ,,
Calcium Acetate (Grey)		-	17 to 14.10.0 ,,
Citric Acid		-	1/2½ to 1/6½ per lb.
Formic Acid	(85%)	-	£46 to £45.10.0 per ton.
Formalin	(40%)	-	40.5.0 to 38 ,,
Lime Juice	(Con.) Nom.	-	17.10.0 ,,
Sodium bisulphite	(60 – 62%)	-	17 to 17.10.0 ,,
Sodium Sulphite	(anhydrous)	-	14 ,,
Sulphate of Ammonia		-	12 to 10.5.0 ,,
Wood Creosote	(unrefined)	-	2/9 to 1/9 per gallon.

Unless otherwise stated, the first of the above prices is that of average quality ruling at the beginning of the year, while the second price is that ruling about November.

The variations in price "throughout the year" refer to quality rather than movements of the market.

The above market price list is intended to indicate the trend of prices over the period under review. The list is based on various issues of the following journals and price lists published during the year 1927.

Lewis and Peat Prices Current; Lewis and Peat, West Indian, Central American and Brazilian Monthly Market Report; Tropical Life; British Trade Journal; Fertilizers and

Feeding Stuffs Journal; Chemist and Druggist; Chemical Trade Journal; Chemical Age; Perfumery and Essential Oil Record.

Oil Seeds and their products.—The Copra market has steadily improved during the year. Palm Oil experienced a somewhat anxious year, declining in price about £5 per ton, in competition with estimated increases of cotton seed oil. A marked improvement took place on publication of the revised estimates of cotton seed production. American enquiry for palm oil has been strong, but it was some time before buyers and sellers prices agreed.

The market for cakes is firm; dealers and feeders have found prices unpleasantly high, and with improving trade in several directions, we are of opinion that prices will be well maintained.

Essential Oils.—With the exception of Citronella and Patchouli, essential oils are of little interest locally. Producers of citronella complain of the present low price, but with indications of reduced production, and increased consumption of the oil, it is anticipated that the recovery of the market, though slow, is inevetable.

Patchouli prices have declined during the year, and taking into consideration the ease with which the market can be satisfied, we can see little prospects of any material advance in the coming year.

Spices.—The feature of the spice market has been the sensational improvement in prices of Chillies, while material improvements in capsicums and pepper are also recorded. As a catch crop, chillies have been grown successfully in this country, while capsicums are more suited to the hills. It is probable that the price of capsicums will be maintained, but the future of chillies is less certain.

Natural Dyes and Extracts.—Annatto and Gambier have proved disappointing. Attempts to market Malayan Annatto proved unprofitable at present rates. The present price of Gambier is unprofitable to producers, and there are no indications in Home reports of early improvement.

Fibres.—Cottons have improved, but hemps—in which this country is more likely to be directly interested,—shew some decline in price.

Of foodstuffs, both cocoa and coffee are firm. There has been increased interest locally in coffee production, but the time has not yet arrived when exports of this commodity from Malaya exceed imports.

Errata:—

Market Price List M.A.J. Vol. XIV No. 12,

Oils-Palm (Lagos) £40 per ton.

Fibres—Manilla 'J' Grade £44 to £45 per ton.

Wood Creosote (Unrefined) 2s. 9d. per gallon.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, Malaya House, 57 Charing Cross, Trafalgar Square, London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price $5.00 per volume.
Vol. V (1917) Nos. 1, 2, 3, 5 & 6 ,, 2.50 per set.
Vol. VII (1919) ,, 2—6 ,, 4.50 per set.

(Vol. VI is out of print.)

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin) Published monthly.

Vol. X (1922) to Vol. XII (1924) — Price $5.00 per volume.
Vol. XIII (1925) and Vol. XIV (1926) — Price $5.00 per volume or 50 cents per single number.

Back numbers of Vols. I.—XII will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased from the Singapore Branch of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, 1909, 20 cts.
2. Root Disease of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, 1910, 20 cts.
4. *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Branch and Stem Disease of *Hevea Brasiliensis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher 1910.
11. Coconut Cultivation, by L. C. Brown, 1911
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*. by K. Bancroft, 1912, 20 cts.

C = Cancelled